TITLE OF THE INVENTION

LIGHT EMITTING ELEMENT AND LIGHT EMITTING DEVICE WITH THE LIGHT EMITTING ELEMENT AND METHOD FOR MANUFACTURING THE LIGHT EMITTING ELEMENT

BACKGROUND OF THE INVENTION

The present invention relates to a high luminance light emitting element mounting an LED (light emitting diode), and to a light emitting device using the light emitting element and to a method for manufacturing the light emitting element, and more particularly to the light emitting element and the light emitting device which are improved in heat radiation thereof.

The LED of compound semiconductor is widely used as the light emitting element because of long life and small size. Further, the LED of GaN semiconductor which emits blue light has been produced, which is used in color display devices as a small color backlight of the portable telephone and an automotive display, and the utilization field is further expanded to the light emitting device as an illumination device having a high luminance and high power.

In recent years, various light emitting elements of the surface mount type are produced because of mass productivity and miniaturization of the elements. However, when such a light emitting element is operated at high luminance and high power, there is a problem of heat radiation. Namely, if the driving current is increased in order to increase the luminance, the loss of electric power

increases in proportion to the increase of driving current, and most of electric energy is transformed into heat, thereby increasing the heat of the LED to high temperature. The light emitting efficiency of the LED (current-light transformation efficiency) decreases as the heat of the LED heightens. Further, the life of the LED becomes short, and the transparency of the resin covering the LED decreases because of color change thereof at high temperature, which causes the reliability of the light emitting element to reduce.

In order to resolve these problems, various heat radiation means have been proposed. As one of the means, a light emitting element is proposed, wherein a pair of conductive members made of heat conductive metal are secured to an insulation member, and an LED is mounted on the conductive members. Japanese Patent Application Laid Open 11-307820 discloses such a light emitting element.

Fig. 16 is a perspective view showing the conventional light emitting element.

The light emitting element 1 comprises a pair of conductive members 2a and 2b made of metal having high thermal conductivity, an insulation member 3 made of resin for insulating the conductive members 2a and 2b and combining the members. The insulation member 3 has an opening 3a having an elongated circular shape. A part of each of the conductive members 2a, 2b is exposed in the opening. An LED 4 is secured to exposed parts of the conductive members 2a, 2b, so that the LED 4 is electrically and thermally connected to conductive members 2a and 2b. The

LED 4 is encapsulated by a transparent sealing member 5.

The light emitting element 1 is mounted on a print substrate 6, and the conductive members 2a and 2b are connected to a pair of conductive patterns 6a and 6b by solders.

When driving current is applied to the LED 4 from the patterns 6a and 6b through conductive members 2a and 2b, the LED 4 emits light. Heat generated in the LED 4 by power loss is transmitted to the print substrate 6 through the conductive members 2a and 2b, so that the heat is efficiently radiated from the print substrate 6 if the substrate is made of a material having high thermal conductivity.

Another conventional heat radiation means is disclosed in Japanese Patent Application Laid Open 2002-252373. In the means, a base for mounting an LED and lead frames as terminal electrodes are made of same material, the base and the lead frames are positioned at the same level, and the base is directly mounted on a substrate.

Fig. 17 is a sectional view showing the conventional light emitting element. The light emitting element 10 comprises a base 11 and a pair of lead frames 12a and 12b which are made of same conductive material and securely mounted on a print substrate 16 by solders 17, so that the base 11 and lead frames 12a, 12b are positioned at the same level, and are thermally combined with each other. An LED 13 is mounted on the bottom of the base 11, thereby to be thermally combined with the base 11.

The anode and cathode of the LED 13 are electrically

connected to the lead frames 12a, 12b by lead wires 14a and 14b. A transparent resin 15 encapsulates the LED 13, lead frames 12a, 12b and wires 14a, 14b.

When driving current is applied to the LED 13 from the print substrate 16 through lead frames 12a and 12b, the LED 13 emits light. Heat generated in the LED 13 by power loss is transmitted to the print substrate 16 through the base 11, so that the heat is efficiently radiated from the print substrate 16 if the substrate is made of a material having high thermal conductivity.

As another means, there is proposed that through holes are formed in the print substrate 16 by conductive patterns, and heat radiation members are disposed on the underside of the print substrate, so that heat is transmitted to the heat radiation members.

In the element shown in Fig. 16, if the print substrate 6 is made of a material having high thermal conductivity such as a metal core substrate, heat radiation effect is expectable.

However, the print substrate 6 is generally made of cheap material such as an epoxy resin having low thermal conductivity. Namely, the thermal conductivity of the epoxy resin is one several hundredth of copper alloy as the material of the metal core substrate. Therefore, the heat is not sufficiently transmitted to the print substrate, thereby raising the temperature of the LED, and reducing the quality thereof.

However, metal core can not be used because of high

manufacturing cost. Furthermore, there is a problem that since it is difficult to wire on both sides of metal core substrate, high density mounting is impossible. In addition, it is necessary to insulate the surface of the metal core substrate by providing an insulation layer on the substrate since the metal core is conductive material. However, the insulation layer reduces the thermal conductivity to decrease the heat radiation effect.

The light emitting element 10 of Fig. 17 also has the same problems as the element of Fig. 16. Since the base 11 is directly adhered to the print substrate 16, the thermal conductivity from the base to the print substrate 16 must be effective. However, if the print substrate 16 is made of epoxy resin, heat radiation effect can not be expected. Further, if the conductive through holes are provided between the base 11 and the heat radiation members secured to the underside of the print substrate 16, heat connection there-between is not so effective, and hence great heat radiation improvement can not be achieved.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a light emitting element having an excellent heat radiation characteristic.

Another object is to provide a high luminance light emitting element using a print substrate for mounting the high luminance light emitting element, the print substrate of which is not limited in material.

According to the present invention, there is provided a light emitting element comprising a base made of heat conductive material and having a heat radiation surface formed on a surface thereof, at least one wire plate made of an insulation material and secured to an upper surface of the base, exposing means for forming an exposed mounting area on the surface of the base, conductive patterns formed on the wire plate, a light emitting chip secured to the base at the mounting area, and connecting means for electrically connecting the light emitting chip to the conductive patterns.

The exposing means is a perforated hole formed in the wire plate, and the connecting means comprises a plurality of lead wires.

An encapsulating member is provided for protecting the light emitting chip.

Cooling fins are provided on the heat radiation surface of the base for increasing heat radiation effect.

A light emitting device is further provided.

The light emitting device comprises a base made of heat conductive material and having a flat plate shape and a heat radiation surface formed on a surface thereof, at least one wire plate made of an insulation material and secured to an upper surface of the base, exposing means for forming an exposed mounting area on the surface of the base, conductive patterns secured to the wire plate, a light emitting chip secured to the base at the mounting area, connecting means for electrically connecting the light emitting chip to the

conductive patterns, a print substrate having conductive patterns provided on an underside thereof and secured to the conductive patterns on the wire plate so as to electrically connect both the conductive patterns.

The print substrate has a hole for discharging the light emitted from the light emitting chip, and a heat radiating member is secured to an underside of the base.

Another light emitting device comprises a base made of heat conductive material and having a flat plate shape and a heat radiation surface formed on a surface thereof, at least one wire plate made of an insulation material and secured to an upper surface of the base, exposing means for forming an exposed mounting area on the surface of the base, conductive patterns secured to the wire plate, a light emitting chip secured to the base at the mounting area, connecting means for electrically connecting the light emitting chip to the conductive patterns, heat pipes projected from a side wall of the base, and a heat radiation member secured to ends of the heat pipes.

Another light emitting device has a plurality of heat emitting elements, each of the light emitting elements comprising a base made of heat conductive material and having a flat plate shape and a heat radiation surface formed on a surface thereof, at least one wire plate made of an insulation material and secured to an upper surface of the base, exposing means for forming an exposed mounting area on the surface of the base, conductive patterns secured to the wire plate, a light emitting chip secured to the base at the mounting

area, connecting means for electrically connecting the light emitting chip to the conductive patterns, wherein the light emitting device has a heat radiation member made of a flexible material, and the light emitting elements are supported on a surface of the heat radiation member.

The present invention further provides a method for manufacturing light emitting elements comprising the steps of preparing a wire plate aggregation having a plurality of divisions, and preparing a base aggregation having a same size as the wire plate aggregation, forming a mounting hole in each division of the wire plate aggregation, and providing a plurality of conductive patterns on each division, securing the wire plate aggregation and the base aggregation with each other, mounting a light emitting chip on the wire plate aggregation at the mounting hole, electrically connecting the light emitting chip with the conductive patterns by wires, encapsulating the light emitting chip and wires by encapsulating member, and dicing the aggregation of the light emitting elements.

These and other objects and features of the present invention will become more apparent from the following detailed description with reference to the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 is a perspective view of a high luminance light emitting element according to a first embodiment of the present invention;

Fig. 2 is a sectional view taken along a line II - II of Fig. 1;

Fig. 3 is a perspective view of a high luminance light emitting element according to a second embodiment of the present invention;

Fig. 4 is a perspective view of a high luminance light emitting element according to a third embodiment of the present invention;

Fig. 5 is a perspective view of a high luminance light emitting element according to a fourth embodiment of the present invention;

Fig. 6 is a sectional view taken along a line VI - VI of Fig. 5;

Fig. 7 is a sectional view of a light emitting device according to a fifth embodiment of the present invention;

Fig. 8 is a perspective view showing a sixth embodiment of the present invention;

Fig. 9 is a side view showing a seventh embodiment of the present invention;

Fig. 10 is a perspective view showing a wire plate aggregation and a base aggregation;

Fig. 11 is a perspective view showing a combination step of the wire plate aggregation and the base aggregation;

Fig. 12 is a perspective view showing a mounting step of an LED;

Fig. 13 is a perspective view showing a wire bonding step;

Fig. 14 is a perspective view showing an encapsulating

step;

Fig. 15 is a perspective view showing a dicing step;

Fig. 16 is a perspective view showing a conventional light emitting element; and

Fig. 17 is a sectional view showing a conventional light emitting element.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Fig. 1 is a perspective view of a high luminance light emitting element according to a first embodiment of the present invention, Fig. 2 is a sectional view taken along a line II - II of Fig. 1.

The high luminance light emitting element 20 comprises a base 21 having a rectangular parallelepiped and made of a metal core material of copper alloy having high thermal conductivity, and a wire plate 22 secured to the upper surface of the base by adhesives 22a opposite an underside heat radiation surface 21a. The wire plate is prepreg and has an insulation quality.

A pair of conductive patterns 23 and 24 are formed on the wire plate 22 by copper foil. The conductive patterns 23 and 24 have terminal portions 23a, 23b, 24a and 24b at respective corners as connecting surfaces. The terminal portions 23a, 23b, 24a and 24b are disposed opposite the heat radiation surface 21a of the base 21, interposing the wire plate 22 and the base 21.

A mounting opening 22b having a circular shape is formed in the wire plate 22 to expose a mounting area 21c of the

upper surface of the base 21. An LED 25 as a light emitting chip is mounted on the mounting area 21c and secured to the area by a silver paste 25a having thermal conductivity. Thus, the LED 25 is thermally connected to the base 21 through the silver paste 25a.

A pair of anodes and a pair of cathodes (not shown) are electrically connected to the conductive patterns 23, 24 by four lead wires 26a, 26b, 26c and 26d. In order to realize a high luminance light emitting element, a large driving current is necessary. To this end, it is preferable to apply a high current to the anodes and cathodes of the LED by two wires respectively. The LED 25, lead wires 26a - 26d and a part of the wire plate 22 are encapsulated by an encapsulating member 27 to protect these members.

When driving voltage is applied to the conductive patterns 23 and 24, the voltage is applied to the LED 25 through the wires 26a - 26d. Thus, the LED 25 is driven to consume the power to generate energy. A part of the energy becomes light which is discharged passing through the encapsulating member 27, and a large part of the energy becomes heat which is discharged from the LED. The heat of the LED is transmitted to the base 21 having excellent thermal conductivity through the silver paste 25a. Thus, the heat is efficiently transmitted to the base 21.

If a heat radiation member having a large heat capacity is adhered to the heat radiation surface 21a of the underside of the base 21, the heat of the base 21 is transferred to the heat radiation member, thereby realizing efficient heat

radiation.

In this embodiment, although one LED is provided, the base 21 is made into an elongated plate, a plurality of LEDs may be mounted on the base. Furthermore, a plurality of wire plates 22 may be secured to the upper surface of the base 21 so as to form the mounting area 21c.

Fig. 3 is a perspective view of a high luminance light emitting element according to a second embodiment of the present invention.

The same parts as the first embodiment are identified by the same reference numerals as those of Figs. 1 and 2.

The high luminance light emitting element 30 has a base 31 having a rectangular parallelepiped and made of a metal core material of copper alloy having high thermal conductivity. A wire plate 22 is secured to the upper surface of the base 31 by adhesives. Since the wire plate 22, LED 25 and encapsulating member 27 are the same as the first embodiment, explanation thereof is omitted hereinafter.

There is formed a plurality of parallel cooling fins 31a on the underside of the base 31 to increase the heat radiation area.

When the driving voltage is applied to the LED 25, the LED 25 is driven to consume the power to generate energy. A part of the energy becomes light which is discharged passing through the member 27, and a large part of the energy becomes heat which is discharged from the LED. The heat of the LED is effectively transmitted to the base 31. Since

there is provided a plurality of cooling fins 31a on the underside of the base 31, the heat is effectively radiated to cool the LED 25. If there is provided a cooling fan to cool the LED 25, the heat radiation is more effectively performed. The cooling fins may be formed on side walls of the base 31.

Fig. 4 is a perspective view of a high luminance light emitting element according to a third embodiment of the present invention.

The same parts as the first embodiment are identified by the same reference numerals as those of Figs. 1 and 2, and explanation thereof is omitted.

The high luminance light emitting element 40 has a base 41 having a rectangular parallelepiped and made of a metal core material of copper alloy having high thermal conductivity.

There is formed a plurality of heat radiation cylindrical holes 41a in one of sides of the base 41 in parallel with the underside of the base. It is preferable that the hole 41a is perforated. If a heat conductive material is inserted in the hole, the heat radiation effect increases.

Fig. 5 is a perspective view of a high luminance light emitting element according to a fourth embodiment of the present invention, and Fig. 6 is a sectional view taken along a line VI - VI of Fig. 5.

The same parts as the first embodiment are identified by the same reference numerals as those of Figs. 1 and 2,

and explanation about a part thereof is omitted.

The high luminance light emitting element 50 has a base 51 having a rectangular parallelepiped and made of a metal core material of copper alloy having high thermal conductivity.

There is formed a cylindrical projection 51a on the base 51 at a corner. On the projection, a terminal portion 51b is provided as a terminal electrode. The wire plate 22 is recessed for the projection 51a. The height of the terminal portion 51b is equal to that of the terminal portion 23a, 23b.

An LED 52 has an anode 52a on the upper surface thereof and a cathode 52b on the underside. The anode 52a is connected to the terminal portion 23a by the wire 26a and the cathode 52b is electrically connected to the terminal portion 51b of the projection 51a through the base 51.

When the driving voltage is applied to the LED 52 from terminal portions 23a and 51b, the LED 52 is driven to consume the power to generate energy. A part of the energy becomes light, and a large part of the energy becomes heat which is discharged from the LED. The heat of the LED is effectively transmitted to the base 51 to cool the LED 52.

In accordance with the fourth embodiment, the base 51 is used as a lead member. Therefore, the LED having electrodes on the upper surface and underside can be used.

Fig. 7 is a sectional view of a light emitting device according to a fifth embodiment of the present invention.

The same parts as the first embodiment are identified

by the same reference numerals as those of Figs. 1 and 2.

The light emitting device 60 comprises the high luminance light emitting element 20 of the first embodiment, a print substrate 61 as a substrate, and a heat radiation member 62 having thermal conductivity.

The print substrate 61 has conductive patterns 61a of copper foil on the underside thereof and a perforated hole 61b having a circular shape. The encapsulating member 27 is projected from the hole 61b and discharges the light emitted from the LED 25 as discharge light 63. The conductive patterns 61a are electrically and mechanically connected to the terminal portions 23a, 23b, 24a and 24b with solders 61c. The heat radiation member 62 is secured to the heat radiation surface 21a of the base 21 to be thermally connected thereto.

When the driving voltage is applied to the terminal portions 23a, 23b, 24a and 24b through the conductive patterns 61a to supply driving current to the LED 25, the LED 25 is driven to emit light. The light is discharged as the discharge light 63 passing through the encapsulating member 27. Heat discharged from the LED is effectively transmitted to the base 21 and to the heat radiation member 62.

In accordance with the fifth embodiment, the heat discharged from the LED 25 is effectively transmitted to the heat radiation member 62 through the base 21 to radiate the heat to the atmosphere. Thus, the heat rise in the LED is held to a minimum limit. Consequently, it is possible to

provide a light emitting device withstanding large current driving to emit high luminance light. Further, by virtue of the heat radiation effect, the deterioration of junctions in the LED and luminance decrease caused by color change of the encapsulating member 27 due to high heat can be prevented, thereby realizing a light emitting device having a high reliability and a long life.

The print substrate 61 connected to the terminal portions 23a, 23b, 24a and 24b is disposed apart from the heat radiation surface 21a of the base 21. Consequently, the print substrate 61 is not necessary to have heat radiation role, and hence it is not necessary to make the substrate with expensive material having high thermal conductivity such as metal core. Thus, it is possible to freely select a cheap material such as glass epoxy resin.

In order to increase the heat radiation effect of the heat radiation member 62, it is preferable to increase area of the member or to form a plurality of projections on surfaces of the member. Although the light emitting element 20 of the first embodiment is used in the fifth embodiment, another element of any embodiment may be used. In the case using the second embodiment, since the base 31 has a high heat radiation effect, the heat radiation member 62 is not necessary to be used.

Fig. 8 is a perspective view showing a sixth embodiment of the present invention. The same parts as the third embodiment shown in Fig. 4 are identified with the same reference numerals. A light emitting device 70 comprises

the high luminance light emitting elements 40 of the third embodiment, a pair of heat pipes 71 as a thermal conductive member and a heat radiation plate 72 made of material having thermal conductivity. In the heat pipe 71, a liquid having thermal conductivity is charged.

An end of each heat pipe 71 is inserted in the heat radiation hole 41a of the base 41, and the other end of the heat pipe 71 is secured to the heat radiation plate 72 so that the base 41 is thermally connected to the heat radiation plate 72.

When the driving voltage is applied to the LED 25, the LED 25 is driven to emit light. The light is discharged as discharge light. Heat discharged from the LED is effectively transmitted to the base 41 and to the heat radiation plate 72 passing through the heat pipes 71.

In accordance with the sixth embodiment, the LED 25 is mounted on the base 41 having thermal conductivity to be thermally connected, the base 41 is thermally connected to heat pipes 71, the heat pipes are thermally connected to the heat radiation plate 72. The heat radiation plate 72 effectively radiates the transmitted heat to the atmosphere. Thus, the heat rise in the LED is held to a minimum limit. Consequently, it is possible to provide a light emitting device withstanding large current driving to emit high luminance light.

Since the heat emitting element 40 and the heat radiation plate 72 can be separated from each other by the heat pipes 71, it is possible to provide a heat emitting

device which is easily assembled in a system.

As the fifth embodiment, a print substrate (not shown) is not necessary to have heat radiation role, and hence it is not necessary to make the substrate with expensive material having high thermal conductivity such as metal core.

In order to increase the heat radiation effect of the heat radiation plate 72, it is preferable to change the shape of the plate, and the number of the heat pipes 71 may be increased. The base 41 and the heat pipes 71 may be connected by adhesives having thermal conductivity.

Fig. 9 is a side view showing a seventh embodiment of the present invention. The same parts as the first embodiment are identified with the same reference numerals. A light emitting device 80 comprises a plurality of high luminance light emitting elements 20 of the first embodiment, a flexible print substrate 81 and an arcuated heat radiating member 82.

The flexible print substrate 81 has three perforated holes 81a, 81b and 81c in which encapsulating members 27 of the light emitting element 20 are inserted. Conductive patterns on the print substrate 81 are connected to terminal portions of the light emitting element 20 by solders 83. The heat radiation member 82 has three recesses 82a, 82b and 82c, in each of which the base 21 of the light emitting element 20 is inserted and secured thereto to be thermally connected thereto.

When driving current is supplied to the high luminance

light emitting elements 20 through the print substrate 81, the LEDs 25 emit lights 84a, 84b and 84c. Heats discharged from the LEDs 25 are transmitted to the heat radiation member 82 through the bases 21 to be radiated.

In accordance with the seventh embodiment, the bases 21 of the LEDs 25 are mounted on the heat radiation member 82 to be thermally connected. The heat radiation member 82 effectively radiates the transmitted heat to the atmosphere. Thus, the heat rise in the LED is held to a minimum limit. Consequently, it is possible to provide a light emitting device withstanding large current driving to emit high luminance light.

As the fifth embodiment, a print substrate 81 is not necessary to have heat radiation role, and hence it is not necessary to make the substrate with expensive material having high thermal conductivity such as metal core.

In the light emitting device 80, a plurality of high luminance light emitting elements 20 are provided. Therefore, for example, when high luminance light emitting elements of red, yellow and green are disposed, it is possible to provide a light emitting device for emitting lights of various colors.

Since high luminance light emitting elements 20 are mounted on the flexible heat radiation member 82, discharge lights can be concentrated as shown in Fig. 9, or diffused by bending the heat radiation member 82 into a convex shape.

Hereinafter, a method for manufacturing a plurality of high luminance light emitting elements at the same time

will be described with reference to Figs. 10 - 15.

Fig. 10 is a perspective view showing a wire plate aggregation 90 and a base aggregation 91. The wire plate aggregation 90 is made of an insulating material and has four divisions. In each division, a conductive pattern 91a is formed by etching of copper and a mounting hole 90b is formed. The base aggregation 91 is made of a metal core having thermal conductivity.

Fig. 11 is a perspective view showing a combination step of the wire plate aggregation 90 and the base aggregation 91. The wire plate aggregation 90 is secured to the surface of the base aggregation 91 by an adhesive to form a wire-plate-combined base aggregation 92.

Fig. 12 is a perspective view showing a mounting step of an LED. An LED 93 is mounted on the wire-plate-combined base aggregation 92 at an exposed portion in the mounting hole 90b and secured thereto by a silver paste.

Fig. 13 is a perspective view showing a wire bonding step. The electrodes of the LED 93 are connected to the conductive patterns 90a by four wires 94.

Fig. 14 is a perspective view showing an encapsulating step. The LED 93 in each division and wires 94 are encapsulated by an encapsulating member 95 of a transparent resin. Thus, each of the light emitting element is completed on the wire-plate-combined base aggregation 92.

The wire-plate-combined base aggregation 92 is diced at boundaries between divisions as shown in Fig. 16 so that a single light emitting element 96 is completed.

Thus, in accordance with the present invention, a large number of light emitting elements can be manufactured at the same time at a low cost.

If light scattering agents, fluorescent substances or beam attenuating agents are included in the encapsulating member 27, various high luminance light emitting elements and devices which are different in directivity and wavelength of the discharge light can be provided.

In accordance with the present invention, the LED is mounted on the base having high thermal conductivity. Therefore, the heat generated in the LED is effectively conducted to the base, so that a high luminance light emitting element having excellent heat radiation effects can be provided.

While the invention has been described in conjunction with preferred specific embodiment thereof, it will be understood that this description is intended to illustrate and not limit the scope of the invention, which is defined by the following claims.